COMPARING THE EATING AND EXERCISE PATTERNS OF NORMAL WEIGHT AND OVERWEIGHT WOMEN

2001

MEAD

APPROVAL SHEET

Title of Thesis: "A Comparison of the Eating and Exercise Patterns of Normal Weight and Overweight Women"

Name of Candidate: Teresa L. Mead
Master of Science Degree
2000

Thesis and Abstract Approved:

Tracy Sbrocco, Ph.D.
Committee Chairperson

23 Feb-01
Date

Evelyn Lewis, M.D.
Committee Member

23 Feb 01
Date

Christopher Robinson, Ph.D.
Committee Member

23 Feb 01
Date

ABSTRACT

Title of Thesis: "A Comparison of the Eating and Exercise Patterns of Normal Weight and Overweight Women"

1Lt. Teresa L. Mead, Master of Science, 2001

Thesis directed by: Tracy Sbrocco, Ph.D.
Assistant Professor
Department of Medical and Clinical Psychology

The purpose of this study was to compare the eating and exercise patterns of normal weight (NW) and overweight (OW) women to empirically improve weight treatment guidelines. Participants—fifteen OW and 11 NW (age-, education-, and ethnicity-matched) women—recorded all foods eaten (on handheld computers) and activities for 2 weeks. Surprisingly, the groups' total daily energy intake—kilojoules (kJ), fat, carbohydrates, and protein—and the macronutrient compositions of meals were not significantly different, but OW's ate more frequently. NW's exercised more frequently each week (3-4 vs. 1-2 /wk) and more often in the evening, and exercised longer (2 hrs. vs. 45 min.), increasing energy requirements to equal OW's. These data suggest that neither NW's nor OW's food intake follows the USDA recommendations, but NW's do exercise according to the USDA recommendations. Focusing on "basic" energy balance may be more effective than focusing on either energy intake or expenditure.

COMPARING THE EATING AND EXERCISE PATTERNS

OF NORMAL WEIGHT AND OVERWEIGHT WOMEN

by

Teresa Mead

Thesis submitted to the Faculty of the
Department of Medical and Clinical Psychology Graduate Program of the
Uniformed Services University of the Health Sciences
In partial fulfillment of the requirements for the degree of
Master of Science 2001

Table of Contents

List of Tables

List of Figures

THEORETICAL BACKGROUND

The American population is now more overweight than ever before and the prevalence of overweight and obesity is increasing disproportionately among youth, females, the lower socioeconomic strata, and certain racial/ethnicity groups (see Table 12 in Appendix; Pi-Sunyer et al., 1998). The National Heart Lung and Blood Institute uses Body Mass Index (BMI; kg/m^2) to categorize degrees of excess weight defining overweight as a BMI between 25.0 kg/m^2 and 29.9 kg/m^2 and obesity as a BMI above 30.0 kg/m^2 (Pi-Sunyer et al., 1998;). From 1960 to 1994, the prevalence of overweight in the United States increased from 30.5% to 32.0% (Pi-Sunyer et al., 1998). The prevalence of obesity, however, increased more dramatically from 12.8% to 22.5% during this same time period (Pi-Sunyer et al., 1998). Thus, the combined prevalence rate of overweight and obesity as of 1994 was approximately 54.9% (Koplan & Dietz, 1999; Pi-Sunyer et al., 1998; Yanovski & Yanovski, 1999). In other words, *over 50%* of the American population is currently above recommendations for weight (Pi-Sunyer et al., 1998; Yanovski & Yanovski, 1999). This is double the prevalence from a century ago (Koplan & Dietz, 1999; Pi-Sunyer et al., 1998).

Health Implications of Overweight

Overweight and obesity are well-accepted risk factors for a multitude of disease states. The most benign of these is the limited daily functioning that many overweight[1] individuals experience when trying to complete the most basic of tasks (e.g., walking up stairs, tying their shoes, etc.). At the other end of the spectrum are very serious, terminal

[1] From this point forward, the term "overweight" will be used to represent both the overweight and obese.

illnesses, such as cardiovascular heart disease (CHD), Type 2 diabetes, hypertension, congestive heart failure, stroke, gallbladder disease, osteoarthritis and some types of cancer (Koplan & Dietz, 1999; Pi-Sunyer et al., 1998; Yanovski & Yanovski, 1999). For example, gaining 44 pounds increases the risk of CHD 2.5 times (Koplan & Dietz, 1999; Pi-Sunyer et al., 1998; Yanovski & Yanovski, 1999). An estimated 325,000 deaths each year are attributable to obesity (Allison et al., 1999) and the direct and indirect costs of obesity account for 10% of the national health care budget (Koplan & Dietz, 1999; Pi-Sunyer et al., 1998). With such a significant morbidity and mortality threat, effective treatment and prevention of weight gain are crucial to decreasing the number of preventable weight-related disease states. Currently, weight loss treatment programs are ineffective and prevention efforts, though on the rise, lag behind the epidemic (Head & Brookhart, 1997). Improved understanding and knowledge of the etiology of overweight are needed. Better understanding can lead to empirically developed, and perhaps more effective, treatment programs and prevention strategies.

Societal Lifestyle Changes: Why Are We So Overfat?

Modernization

"Lifestyle is…driven by basic attitudes and ideas about how life should be lived, including conditions considered necessary for happiness and satisfaction, and methods of seeking those conditions…" (Head & Brookhart, 1997, p. 309). Modernization has significantly changed the American lifestyle and is frequently studied as a major contributor to the weight gain trend in the U.S. Over the last hundred years, American society has witnessed a dramatic reduction of physically demanding tasks, changes in the

composition of foods and the availability of foods, and shifts in eating patterns. Each of these factors of life style contributes to energy intake exceeding expenditure.

Decreased Physical Activity

In the early 1900's, an Agrarian culture necessitated physically demanding processes to obtain and prepare food. The dawn of the Industrial Era made life less physically demanding through the mass production of consumer goods (including food). In the current Technological, Computer, or Information Age, the fast-paced, high-stress work environment requires even less physical activity than the previous era. In all aspects of life—from work to food preparation to leisure activities—technological advances have enabled Americans to be less physically active and yet more productive. In fact, from 1965 to 1977, daily caloric expenditure decreased nearly 200 kilocalories (Tippett & Cleveland, 2000) because of the advent of affordable automobiles, mass transportation, and television. It is likely a similar decrease in expenditure has occurred over the last two decades as significant numbers of individuals rely on computers for both work and leisure.

Physically demanding career and household tasks have been significantly improved resulting in reduced time and effort needed for completion while continually improving productivity. For example, farmers now have machines to feed animals and tractors to plow the fields. Shopping can be done on-line and washing clothes and dishes is done with machines. While these examples demonstrate tasks that can still be physically demanding, even the less physically demanding tasks, such as typing, have been modified to significantly reduce physical activity. Thus, Americans are at higher risk for weight gain—especially those who are genetically predisposed, have decreased

physical demands, and/or have poor dietary intake (Rozin, Ashmore, & Markwright, 1996). There is a resultant need for greater amounts of physical activity and scheduled activities in today's society.

Changes in Food Composition

Modernization has also had a significant impact on the types and composition of foods available to consumers. Although studies indicate the average fat consumption in the American diet has not increased dramatically (from 33% in the early 1900s to about 37-38% in the 1980's) the amount of fat available in the food supply has increased from 2% to 20% (Nestle & Woteki, 1999). In 1970, fats and oils for cooking were the primary sources of dietary fat at 43% followed by meat, poultry, and fish at 35%. Although these original source foods of fat are relatively high in fat, some are also valuable sources of protein, vitamins, and minerals (such as calcium and iron). By 1994, the supply of dietary fat from cooking fats and oils increased to 52% and the supply from meat, poultry, and fish decreased to 25%--which may be an indication that cuts of meat are becoming leaner and healthier (Putnam & Gerrior, 2000). However, during this time, the consumption of whole-grain wheat foods significantly decreased the consumption of fruits and vegetables only moderately increased suggesting that the average American diet is not as healthy as it once was (Putnam & Gerrior, 2000).

This increase in low-nutritive, high-fat foods is the result of the types of foods available. The current source foods for fat are much less healthy—containing vegetable oils and other processed ingredients (Nestle & Woteki, 1999) that provide fewer nutrients and are higher in calories, sodium, and fat (Prattala & Roos, 1999). Therefore, while the actual amount of fat consumed appears not to have increased significantly, the nutritive

value of the fat source foods has decreased. This situation increases the likelihood for weight gain since people must still eat the nutritive foods in addition to the non-nutritive foods—significantly increasing caloric intake.

Eating Patterns

Despite increased productivity, people actually spend more time working and less time focusing on meals (Nestle & Woteki, 1999; Schlettwein-Gsell et al., 1999). This may contribute to irregular eating patterns and has supported an increase in the market for easily prepared foods. When foods had to be prepared from the primary ingredients, meals were planned, relatively lengthy, and typically viewed as family events (Akan & Grilo, 1995; Lin, Guthrie, & Frazao, 2000; Nestle & Woteki, 1999; Schlettwein-Gsell et al., 1999). Very few people ate at restaurants or away from home (Lin, Guthrie, & Frazao, 2000). The Industrial Era brought about mass production of goods and sent more people away from home to work. As a result, the time allotted for meals shortened, but pre-packaged foods were still not commonplace. Consequently, food preparation was still an important part of the day (Lin, Guthrie, & Frazao, 2000). Meals today are much more sporadic and short-lived. Significant decreases in preparation requirements for foods have enabled people to eat on the run, wait to prepare foods until they are very hungry, and eat out more frequently. In fact, in 1995, 25% of all meals were eaten away from home compared to 16% in 1977 (Lin, Guthrie, & Frazao, 2000). Sporadic eating patterns and excessive consumption of pre-packaged and fast-foods—which are usually high in fat and calories—may also contribute to weight gain.

Etiological Theories of Overweight

Given that societal changes have impacted a majority of the American population, why aren't all Americans overweight? A greater understanding of the differences between normal weight and overweight individuals may provide information important to understand, prevent, and treat overweight. Biological, behavioral learning, and cognitive theories have all been proposed as explanations. More likely, all three contribute to understanding, but as of yet, no definitive research exists to link these theories into a biopsychosocial model to completely explain the etiology of overweight.

The Biological Perspective

The biological explanation of weight gain holds that people have a genetically predetermined "set point" for their body weight that is "regulated by a complex interaction of neural, hormonal, and metabolic factors" (Keesey, 1986; Schlundt & Johnson, 1990). When people modify their eating and exercise habits to go below their set point, their body will react as if starving and cause binging, excessive fat storage, etc. to make the body more efficient at maintaining the set point weight (Keesey, 1986; Schlundt & Johnson, 1990). This process (if not countered with exercise and muscle building activities) changes the body composition making further weight loss attempts more difficult and weight regain easier. Theorists studying weight loss from the biological perspective have spent a great deal of time using animal models to look for variances in hormones, taste preferences, and genetic structure (Hagan & Moss, 1997; Perez, Fanizza, & Sclafani, 1999; Stanley et al., 1989), but have not been able to link specific hormones, taste preferences, genes, or any other specific physiological component to weight gain for a specific number of the overweight. This indicates that

there may be many reasons for weight gain or several subtypes of overweight people and not one just etiology. This indicates that the etiology of overweight may be mulit-dimensional at best.

Currently, a debatable 66-70% of body weight is attributable to genetically pre-determined metabolic rates and a set number of lifelong fat cells (Stunkard et al., 1990). Resting metabolic rate can differ by as much as 1000 kilocalories per day depending on body fat composition and activity levels in obese age-, weight-, and height-matched women (Brownell & Wadden, 1992). While biological mechanisms and genetic components clearly play a role in body weight and obesity, these components only provide a "tendency to develop obesity, the expression of which is affected by diet and exercise" (Brownell & Wadden, 1992). Currently, this conceptualization may be more appropriately applied to identifying high-risk groups for prevention.

The Behavioral Learning Perspective

Behavioral theorists do not deny a biological component to weight, but do not place as much emphasis on it since the expression of overweight depends on behavioral factors (Booth, 1999; Brownell & Wadden, 1992). The behavioral theory of how normal weight individuals have remained so is that they have learned to adapt to societal changes by consciously increasing their activity and/or eating healthier foods to balance their caloric intake and expenditure (Akan & Grilo, 1995; Wadden, Foster, & Letizia, 1994). Overweight individuals' learned eating patterns—whether through family influences or rituals or reinforcement of behaviors in childhood—have consistently been found to be of significant influence in the etiology of obesity—especially lifelong obesity (Cavadini et al., 1999; Ganley, 1992; Roos & Prattala, 1997; Wardle et al., 1997).

Learned eating/hunger cues can be as simple as a specific chair that becomes associated with eating and eventually feelings of hunger (Brownell & Wadden, 1992) or as complex as physiological responses (that influence mood) to certain foods. In addition to conditioned cues, eating behaviors are also well-established patterns usually learned in childhood (Fairburn & Wilson, 1993). For example, being reinforced for finishing all of the food on the plate—which disregards physiological satiation cues—can lead to overeating when/if serving sizes are too large or are not controlled. These and other learned behaviors are difficult to modify because of the history of reinforcement. Attempting to change eating behaviors without instating reinforcers for new behaviors can lead to a relapse of old behaviors and weight regain.

The Cognitive Perspective: Dietary Restraint

Much of the research on the cognitive aspects of overweight has focused on differences between restrained (defined as the voluntary restriction of food intake in order to control body weight) and non-restrained subjects (Ganley, 1992; Lowe et al., 1996; Ruderman, 1986). Though not differing in body weight per se, restrained eaters are defined as individuals who limit their food intake for the purposes of weight control (Bourne et al., 1998). This construct was originally developed to describe how and why the eating patterns of obese and normal weight people differ (Ruderman, 1986). American culture and current societal norms dictate that being "thin" is desirable—particularly for women. The pressure to be slender has led to a significant increase in dieting practices (Brownell & Wadden, 1992; Fairburn & Wilson, 1993).

While weighing within the range specified by the Food and Drug Administration (FDA) is healthier than carrying extra weight, the desired "ideal" body weight dictated by

appearance of today's advertising models and icons is often lower than this healthy range (Fairburn & Wilson, 1993; Pi-Sunyer, 1996). This unrealistic ideal coupled with the underlying belief that people can completely control their body weight and shape, leads to a society that is perpetually dieting and has a negative bias against overweight people (Fairburn & Wilson, 1996). Society, especially those who have failed at dieting, often place blame for weight gain on the overweight individual rather than the diet program or unrealistic nature of the diet behaviors. Consequently, diet programs do not change and those who have difficulty maintaining a normal weight are seen as lazy and undedicated (Fairburn & Wilson, 1993; Wadden, Foster, & Letizia, 1994). The negative stigma against the overweight often leads to lowered self-esteem and negative emotions (e.g., frustrations, depression, etc.), which, in turn, leads to more dieting attempts (Fairburn & Wilson, 1993; Wadden, Foster, & Letizia, 1994).

Negative feelings and low self-esteem have been shown to be associated with binge eating and overeating. A vicious cycle of going from binge eating to extreme dietary restraint or from extreme caloric restriction (from dieting) to overeating often results in weight gain beyond the original weight (Fairburn & Wilson, 1993; Wadden, Foster, & Letizia, 1994). Those who practice extreme dietary restraint (i.e, very low caloric intake) are rarely able to maintain very low caloric intake (Fairburn & Wilson, 1993; Wadden, Foster, & Letizia, 1994) and disinhibit (i.e., compensating by overeating). According to the "disinhibition hypothesis," dieters overeat after disruptions in self-control, such as dysphoric mood, subjective or objective overeating (Ruderman, 1986). Despite the high prevalence of dieting in the U.S. and the fact that many normal weight individuals exhibit dietary restraint patterns we know surprisingly little about the impact

of dieting on food intake, meal patterns, or what "normal" eating patterns are.

Differences Between Overweight and Normal Weight Individuals

What are Typical Meal Patterns?

The general prescription for healthful meal patterns is three meals per day plus two or three light snacks [American Dietetic Association (ADA), 2000; USDA, 2000]. This recommendation is supported by the hypothesis that snacking between meals will decrease the likelihood of overeating during meals. However, there is very little evidence to support this hypothesis and some to refute it (Johnson et al., 1995; Longnecker, Harper, & Kim, 1997; Roos & Prattala, 1997; Schlundt et al., 1993). For example, those who follow the prescribed meal pattern actually have higher caloric intakes and BMI's (Longnecker, Harper, & Kim, 1997; Roos & Prattala, 1997). This suggests that despite adding snacks to their daily meal plans, these individuals do not decrease their caloric intake during meals leading to greater daily caloric intake. Surprisingly, hunger between meals has also not been found to lead to less healthy eating behaviors (Schlundt et al., 1993). Furthermore, unstructured free time, evenings, being away from home, and bored when not hungry were the most frequently reported antecedents to overeating for both overweight and normal weight subjects, not being hungry between meals (Johnson et al., 1995; Schlundt et al., 1993). Ironically, moderate levels of reported hunger resulted in the most control over the amount of food eaten for both overweight and normal weight individuals (Johnson et al., 1995). Finally, American adults on average eat only 3.12 times per day (when drinks were excluded) and over 90% of the population eats between 1.5 and 4.49 times daily—which is less than the recommended five meals and found

among both the normal weight and overweight (Longnecker et al., 1997).

Even mood and affect may have a greater impact on more pathological behaviors such as binging. Although binging (overeating combined with a sense of loss of control) is more likely to occur following skipped meals (especially lunch) and other binging episodes for both the overweight and normal weight, these do not seem to be the most important factor (Fairburn & Wilson, 1993; Johnson et al., 1995). For the obese, negative mood and/or being alone are more likely to lead to a binge than skipping meals (Fairburn & Wilson, 1993; Johnson et al., 1995). For the normal weight, being in the company of others who were binging whereas is more likely to lead to binging than skipping meals (Fairburn & Wilson, 1993; Johnson et al., 1995).

Since most Americans do not follow the prescribed meal pattern and this pattern has not been empirically validated as a means of maintaining normal weight, understanding the current behaviors of normal weight individuals becomes more important. Several common eating patterns have been found among normal weight individuals in the U.S. (Johnson et al., 1995; Schlundt et al., 1993). First, breakfasts and snacks were higher in carbohydrates and lower in protein than lunch and supper. Second, fat intake was high during episodes of craving sweets, which had a higher probability of occurring when the subjects were bored, afraid, depressed, or upset. Additionally, craving sweets occurred more frequently at work and in the car and often resulted in impulsive eating and overeating (Schlundt et al., 1993).

Macronutrients: Does Intake Differ by Weight?

For adults, the U.S. Department of Agriculture (USDA) recommends a caloric intake between 1,600 and 2,800 kilocalories per day (depending on age, gender, height,

and activity level) with 30% of these kilocalories derived from fat, 60% from carbohydrates, and 10% from protein (USDA, 2000). More specifically, the USDA recommends about 1,600 kilocalories for women, young children, and older adults and 2,200 kilocalories for older children, teen girls, active women, and most men (USDA, 2000). Interestingly, individuals who spend more time preparing their meals are more likely to include a wider variety of foods with more nutritive value and come closer to matching the USDA recommended daily allowances (RDA; Lennernas and Andersson, 1999). According to Lennernas and Andersson (1999), "irregular work hours" and lower income levels are reported to be the major barrier to healthy eating because of the lack of time spent on meal preparation. It appears that those who have the monetary freedom to purchase raw and unprocessed foods do so more often (Kowrygo et al., 1999).

Normal weight individuals may be keeping their caloric intake closer to the USDA recommendation by snacking less, snacking on lower calorie foods, monitoring the macronutrients of their foods, and balancing food intake for each day (Booth, 1999; Schlettwein-Gsell et al., 1999). Those who skimp on kilocalories throughout the day appear to eat more overall (total daily calories) and to have higher body fat percentages (Lennernas & Andersson, 1999; Schlettwein-Gsell et al., 1999; Wahlqvust et al., 1999). In summary, most individuals do not follow the USDA recommendations and those who do may actually weigh more (Lennernas & Andersson, 1999; Schlettwein-Gsell et al., 1999; Wahlqvust et al., 1999). Therefore, new meal pattern recommendations may be needed for a society that is relatively sedentary—especially since the prescribed pattern may ironically lead to overeating.

Empirical Information on Eating Patterns: Method of Study

One of the major problems with the available information on overweight and normal weight individuals eating patterns is the method of study. Eating behavior has been shown to be particularly sensitive to situational factors including internal emotional and physiological states (Ganley, 1992). Additionally, eating behavior differs across certain subgroups of the population (Adran & Grilo, 1995; Allan, 1998). An empirical examination of eating requires compiling data from multiple methods in order to develop a more fine grain model of how individuals eat. Key parameters include gender, eating pathology, psychological states, body weight, and biological states. The impact of lifestyle and behavioral differences in eating and activity among overweight and normal individuals has been examined in a variety of ways including epidemiological studies using laboratory studies, self-report, and dietary self-monitoring studies (Brownell & Wadden, 1992). Given the reactivity of eating behavior to a variety of factors, each method has particular strengths and weaknesses, which are briefly reviewed in the following.

Laboratory Studies of Eating Behavior

Laboratory studies of eating behavior are frequently designed to examine a number of hypothesized influences of eating behavior (Brownell & Wadden, 1992). Generally, in such studies, conditions that are expected to increase or decrease food intake for individuals, or groups of individuals are manipulated, and the amount and types of foods eaten are recorded (Brownell & Wadden, 1992). Both external (e.g., presence of others, information about food content, etc.) and internal cues (e.g., emotions, hunger states, etc.) are studied extensively as differentially influencing food intake for

overweight and normal weight individuals (e.g., Brownell & Wadden, 1992; Westerterp, Nicolson, Boots, & Mordant, 1988; Westerterp-Plantenga, Wouters, & Ten Hoor, 1991). Similar methods are used to explore the differences between restrained and non-restrained subjects (Lowe et al., 1996).

The information gleaned from these types of studies is invaluable, however the external validity of such studies is limited. Perhaps the biggest limitation in the quest for a more thorough understanding of eating patterns is the fact that laboratory paradigms represent only one snapshot in a very complex behavior pattern. If the experiment is limited to one meal eaten alone or in front of strangers (knowingly observed; e.g., Westerterp-Plantenga et al., 1991; Westerterp et al., 1988), the situation and eating pattern are bound to be atypical for the participants. Since this snapshot may not actually capture the complexity of daily eating patterns, it is not surprising that some laboratory studies observing overweight and normal weight subjects find no differences in food consumption (Klesges, Hanson, Eck, & Durff, 1988; Leibel & Hirsch, 1984 as cited in Brownell & Wadden, 1992).

Furthermore, if the subjects' eating and activity behaviors are not typically monitored or reported for the whole day (both before and after the experiment; Schlundt, 1985,1995), many undetected and important eating variables will not be detected. This design does not account for variances in important energy intake variables such as activity levels, frequency of eating, or time of day of eating. For example, if a subject restrains eating during the experiment and then overeats upon returning home, the amount of food eaten in the experiment will not be consistent with the subject's typical pattern.

The time of day and day of week the experiment are also fundamentally important and usually not considered in laboratory studies. Due to pulsatile secretions of some hormones (such as cortisol) and the resultant lag times, changes in hormonal levels occur at roughly 24-hour intervals (Comperatore & Krueger, 1990). These periodic changes, known as circadian rhythms, influence sleep, metabolism, and a variety other hormone-influenced functions. Some biorhythms follow weekly cycles while others follow monthly cycles. Consequently, looking only at one part of the day or even one day of the week is not sufficient for a full understanding of individuals' eating patterns. The time of day, for example, that meals are eaten has been shown to influence how much is eaten throughout the day. In one study, those who ate breakfast and dinner earlier in the day had lower body mass indices and waist-hip ratios and had lower fasting blood glucose levels—indicating a caloric intake balance for a normal weight (Wahlqvist et al., 1999; Winkler, Doring, & Keil, 1999).

Research has also shown that emotions significantly impact food intake—which may not be fully captured in a laboratory setting (Johnson et al., 1995). Although emotions can be induced in a laboratory setting and food provided as a dependent variable (assumedly a coping mechanism), participants in these studies may actually utilize more adaptive coping mechanisms in natural settings (Ganley, 1992). As with nearly all observations of behaviors, these limitations are accepted for the sake of isolating a specific behavior (e.g., eating in a buffet setting).

Retrospective Self-Report of Eating Behavior

The assessment of eating behavior relies on retrospective self-report both in the clinic and in the research environment. The most common method of assessing dietary

intake is to obtain a "24-hour Recall" by asking the individual to recount all foods consumed over the last day. Studies employing self-report recall measures, attempting to overcome these limitations, also have limitations—namely recall bias, limited recall capabilities, and underestimating their portion sizes (Menon, 1993). People frequently underestimate portion sizes and their caloric intake when asked to recall the food intake (Mertz et al., 1991; Smith, Jobe, & Mingay, 1991). Methods in which subjects are asked to recall the types and quantities of foods eaten from the previous day or two is likely to produce errors of recall bias and memory limitations (Schoeller, 1988). Since recalling details about frequently occurring events becomes more difficult and eating is a frequently occurring specific event, recall is likely to be limited for most individuals (Fries, Green, & Bowen, 1995). Subjects rely on generic memory about their own diets when they report food intake based on memory. Consequently, research designs imploring methods in which subject recall foods eaten may be useful when general food habits are of interest, but do not provide enough information for weight treatment studies (Smith, Jobe, & Mingay, 1991). In summary, monitoring 24 to 48 hours is not sufficient to get an accurate picture of meal patterns (Schlundt, 1995) and recall for eating events for longer than this is very poor suggesting that recall methods may not be the most appropriate when specific dietary intake is fundamental to the study.

Self-Monitoring of Eating Behavior

Self-monitoring with eating diaries, although a type of self-report, decreases the likelihood of recall error and bias if the data are collected prospectively because subjects do not have to rely on long term, often fallible, memory (Schlundt, 1995; Wilson & Vitousek, 1999). When subjects are compliant and record meals immediately after they

are eaten or immediately before a planned meal, they do not have to rely on their own recall, which may be biased. For this reason, this method of observation can be used to assess longer periods of time and has therefore been employed more frequently by researchers. Self-monitoring allows researchers to assess the environment surrounding, behavioral, physiological, and emotional antecedents, and the consequences of eating by having the subjects record this information while they are in the eating situation (Schlundt, Johnson, & Jarrell, 1985). Temporal parameters, such as meal duration, meal frequency, and inter-meal interval can also be analyzed using this method because the times that the meals were eaten are also frequently recorded (Schlundt, 1995).

Despite the improved external validity of self-monitoring studies, there are still several limitations. First, subjects still have to estimate portion sizes and calculate nutrient content—at which they have proven to be very inaccurate (Fries, Green, & Bowen, 1995; Smith & Jobe, 1993). Second, undetectable systematic bias in reporting also adversely affects the accuracy of the data, such as underestimating portion sizes (Muhlheim, Allison, Heshka, & Heymsfield, 1998; Smith & Jobe, 1993). Third, when the diaries are handwritten, inaccuracies of recording by either or both the subject and the researcher (transferring data to a computer) can occur (Smith & Jobe, 1993).

Most of these problems can be solved by using modern technology and improved research designs. Handheld computers with pre-programmed food lists and portable scales are now available to be given to subjects for monitoring their food intake and physical activity. The computers and portable scales are novel for most participants—which increases the likelihood that they will use them (Sbrocco, Nedegaard, Stone, & Lewis, 1999). The scales eliminate the reliance on subjects' ability to estimate food

quantities—they simply have to weigh the food and enter the weight into the computer—increasing the accuracy of recorded portion sizes. Finally, the foods recorded will be less subject to recording and interpreting error and increase the accuracy of the recording of the contents of the food. Despite these advantages, some subjects may still fall prey to social desirability and enter foods consistent with a positive image (Sbrocco, Nedegaard, Stone, & Lewis, 1999).

Current Study

Since the differences—if they truly exist—between normal and overweight individuals' eating habits are still not fully understood and only 50% of the population is overweight when societal changes have affected nearly everyone, understanding these differences is fundamental to decreasing the prevalence of overweight. This gap in experimentally and empirically-based information and the information given to individuals attempting to lose weight (Pfau, 1999) is astonishing, but may help explain why weight loss programs have been unsuccessful (Head & Brookhart, 1997).

The purpose of the current study is to gain a greater understanding of the eating patterns of normal weight and overweight women. The participants in this study self-monitored their eating and exercise behaviors in natural environments for a two-week period—which is much longer than typical self-monitoring studies—utilizing sophisticated technology (handheld computers and portable scales) to improve the accuracy of the subjects' self-monitoring.

Hypotheses

The author hypothesized that overweight subjects would have greater energy (kJ) and fat

intakes. Furthermore, for both groups the size (measure in kJ) of the daily meals would increase throughout the day (excluding snacks), such that breakfast would be the smallest meal of the day, dinner would be the largest meal of the day, and lunch would be larger than breakfast and smaller than dinner. It was also hypothesized that each meal would have a similar macronutrient composition to the other meals (e.g., composed of %60 carbohydrates, 30% protein, and 10% fat), but that the overweight subjects' meals would consist of more kJ and fat than the normal weigh subjects' meals. The data collected on meal frequency was deemed to be exploratory. The overweight subjects were hypothesized to exercise significantly less often and with less intensity. Furthermore, it was hypothesized that the overweight subjects' exercise sessions would be correlated with food intake. Finally, it was hypothesized that the overweight subjects would have a higher basal metabolic rate and a lower daily metabolic rate, which includes the energy burned through daily activity and planned exercise.

METHOD

Participants

Twenty-nine non-smoking women (12 normal weight and 17 overweight) were recruited by advertisement from the Washington, D.C. metropolitan area. Women 30% to 60% above ideal body weight (IBW range: 130 to 160%; Metropolitan Life Insurance Company Height Weight charts, 1983; OW) were recruited to participate in a weight management program and were paid $25 upon completion of the two-week monitoring period (they were also paid throughout the twelve week weight management program). Age- and ethnicity-matched normal weight, non-eating disordered women (IBW range: 90 to 110%; NW) were recruited to participate in a two-week study on eating patterns

and paid \$50 to participate. To qualify for the program, women were required to keep eating diaries for two weeks using the handheld computers. Participants were evaluated by a physician and determined to be free of major medical problems that could impact eating patterns and/or weight (e.g., hypertension, diabetes, bulimia, thyroid disease, etc.) and could not have recently lost weight (10 lbs. in the past month or 20 lbs. in the past 6 months).

Measures

Anthropomorphic Measures

Weight (in lbs.) was measured on a balance beam scale at orientation session 1 and two weeks later at session 2. Height, to the nearest ½ inch, was measured. Body mass index (BMI) was calculated from weight and height measurements.

Eating Patterns

Participants kept computerized self-monitoring diaries for two weeks, using the Psion 3.0A/C palmtop computers (Psion PLC, London, England). Dietary intake was recorded using the Comcard Compute-A-Diet Nutrient Balance System (1993) software program, which contains almost 4,000 foods from the United States Department of Agriculture database. Participants weighed all foods in grams or ounces using portable scales and recorded situational parameters associated with eating using the WEIGHT program, a software program developed for this study.

Activity Patterns

Participants kept daily exercise logs for two weeks concurrent with their eating

diaries. They were instructed not to change their activity patterns for the purposes of the study. They were told that this information was being collected to account for caloric needs. They recorded date and time of day, activity completed, and duration. Using the Nutritionist IV (First Databank, 1993) software program, the caloric equivalents of these activities were coded for the participants' weights.

Procedure

Participants were telephoned and screened for age, weight, and health status requirements. Those meeting initial criteria were given a medical information form to be completed by their physician and scheduled for two group meetings, held two weeks apart. The normal weight and overweight women met separately, but in the initial sessions for both groups, the study was explained and informed consent was obtained. Participants were weighed, completed detailed medical history reviews (signed by their physicians), received 1½ hours of instruction on the use of the Psion, and administered the Eating Disorders Examination (EDE; Fairburn & Cooper, 1993). The EDE, a reliable and valid measure of a wide range of eating disorders in the form of structured interviewing, was administered by trained graduate students and research assistants and used to assess or detect any eating pathology. None of the normal weight subjects met DSM-IV criteria for any eating disorder. OW subjects meeting the criteria for Binge Eating Disorder were not used in the current study, but were allowed to participate in the weight loss group.

Participants were instructed to weigh all foods and caloric beverages consumed for the next two weeks. They were informed that the purpose of the study was to understand typical eating patterns and therefore it was important that they not change

their eating or exercise behaviors for the study. They were instructed to maintain their current weight to the best of their ability (not to lose or gain weight). Participants entered sample meals in front of research assistants. All participants were also provided with written instructions and a study information telephone number to call with questions. They were called within the next 2 days, after a week, and near the end of the second week to ensure they were not having difficulties using the Psion computer. At the second session, participants returned their computers and were weighed.

RESULTS

Demographics

As expected and shown in Table 1, the overweight and normal weight groups differed by weight [t (27) = -6.814, $p < 0.001$] and BMI [t(27) = -7.81, $p < 0.001$], but did not significantly differ by height [t(27) = -0.944, p = 0.354], age [t(27) = -1.232, p = 0.229], education [t(27) = -0.308, p = 0.760], or ethnicity [χ^2 (1, N = 29) = -0.427, p = 0.670]. The overweight group was 64.7% (n = 11) Caucasian, 29.4% (n=5) African American, and 5.9% (n =1) Hispanic. The normal weight group was 66.7% Caucasian (n = 8) and 33.3% (n = 5) African American (n = 4).

Exploratory data analysis designed to (Tukey, 1997) detect outlying data resulting from dieting behaviors or inaccurate recording. Two participants, one subject in each of the normal weight and overweight groups—who consumed 1.5 standard deviations above the mean kilojoules (kJ) for their respective groups and did not gain more than four pounds over the two-week period—were deemed outliers. Another participant in the overweight group was excluded for "dieting behaviors" indicated by a

greater than four pound weight loss in one week and a kJ intake one standard deviation below the mean for the overweight group.

Post hoc power analyses both including and excluding these subjects were conducted. Excluding the outliers decreased within-group variance, increasing effect size from 0.2626 to 0.3563 and increasing power from 0.276 to 0.4146 [Fcrit $(1,27) = 4.210$; Faul & Erdfelder, 1992]. Excluding these subjects did not significantly affect any of the demographic variables and the remainder of the analysis was conducted excluding these subjects.

<u>Eating Patterns</u>

Daily Macronutrient Intake

Since the data were collected over a two week period, the subjects' kJ and fat intakes were analyzed using a repeated measures ANOVA with week as a repeated measure and group as a between group measure (see Table 2). Within both groups, the subjects' energy and fat intakes within both groups did not significantly differ by week [NW: kJ: $F(1) = 3.245$, $p = 0.084$ and fat: $F(1) = 2.769$, $p = 0.109$; OW: kJ: $F(1) = 3.245$, $p = 0.084$ and fat: $F(1) = 2.769$, $p = 0.109$] and no group-by-week interactions were found for either variable [kJ: $F(1) = 1.320$, $p = 0.262$ and fat: $F(1) = 0.197$, $p = 0.661$]. Although there was a trend for the normal weight individuals' energy to decrease across the weeks (potentially due to low power), the data for the two weeks were collapsed for the remainder of the analyses.

Mean daily kJ and fat intakes for the total observation period for each group are presented in Table 3. Consistent with the hypotheses, there was a trend for the

overweight subjects to have a greater daily energy intake [$F(1) = 3.652$, $p = 0.068$] and to consume more fat [$F(1) = 4.198$, $p = 0.052$]. The overweight subjects consumed approximately 1500 more kJ (400 kilocalories) and 20 more fat grams per day than did the normal weight subjects.

The macronutrient composition of daily energy intake—percentage from fat, carbohydrates, and protein—was further examined for differences in the quality of energy intake (see Table 4). Surprisingly, there were no differences found between the composition of the groups' daily energy intake [fat: $F(1) = 0.493$, $p = 0.489$; carbohydrates: $F(1) = 0.041$, $p = 0.841$; protein: $F(1) = 0.878$, $p = 0.358$]. Interestingly, both groups were above the USDA recommended range for percentage of daily fat percentage (below 30%), low for percentage of daily carbohydrate percentage (60%), and on target for daily protein percentage (10%; USDA, 2000). The similarities in the composition of the groups' foods suggest that either the groups were eating and recording similar foods throughout the day or that the composition of the types of foods eaten and recorded was equitable by the end of the day. To gain a clearer understanding of this, the contribution by each meal to the total energy intake—in the form of fat, carbohydrates, and protein—and the macronutrient composition of each meal (breakfast, lunch, and dinner) were examined separately.

Daily Macronutrient Intake by Meal

The contribution of each meal to the daily energy and macronutrient intake is important in understanding the differences in meal patterns between overweight and normal weight individuals. The percentages that each meal contributed to total daily energy intake for each macronutrient are depicted in Figure 1. Using a MANOVA, the

data were analyzed for both between and within group differences. There were no significant differences found between the groups' percentages of total daily kJ of fat, carbohydrates, or protein from each meal ($p > 0.05$).

However, there were differences between groups in comparative meal size. For the normal weight group, snacks provided a lower percentage of kJ than breakfast ($p = 0.027$), lunch ($p = 0.001$), and dinner ($p = 0.001$); and breakfast provided a significantly lower percentage of daily kJ than dinner [$p = 0.022$; $F(3) = 9.025$, $p = 0.006$]. A similar pattern was seen in the percentage of daily kJ from fat for this group. Snacks provided a significantly lower percentage of the total daily kJ from fat than lunch ($p = 0.003$) and dinner ($p = 0.012$), and there was a trend to have a lower percentage than breakfast ($p = 0.151$). There were no other significant differences between the percentages of kJ from fat provided by the meals. Snacks provided a significantly lower percentage of the total daily kJ from carbohydrates than did lunch ($p = 0.001$) and dinner ($p = 0.001$), but not breakfast ($p = 0.057$). Finally, snacks provided a lower percentage of kJ from protein than did breakfast ($p = 0.014$), lunch ($p = 0.001$), and dinner ($p = 0.001$). Both breakfast ($p = 0.002$) and lunch ($p = 0.007$) had lower percentages of kJ from protein than did dinner, but were not significantly different from each other. In summary, as expected for normal weight subjects, dinner was the largest meal, providing the most energy and the largest percentage of macronutrients while snacks and breakfast were the smallest meals, providing the lowest percentages of macronutrients.

For the overweight group, eating patterns were similar to the normal weight group. Snacks and breakfast were the smallest meals, providing lower percentages of the total daily energy than (snack/lunch: $p = 0.001$; breakfast/lunch: $p = 0.006$) or dinner

(snack/dinner: $p = 0.002$; breakfast/dinner: $p = 0.002$). However, unlike the normal weight group, snacks and breakfast for the overweight group were approximately the same size, providing similar percentages of total daily kJ [$p = 0.137$; $F(3) = 7.549$, $p = 0.004$]. These same patterns for percentages of kJ from fat were seen: both snacks and breakfast meals were significantly lower than lunch ($p = 0.010$; $p = 0.001$, respectively) and dinner ($p = 0.017$; $p = 0.001$, respectively), but not significantly different from each other ($p = 0.695$). Snacks provided the lowest percentage of kJ from carbohydrates [breakfast: ($p = 0.057$); lunch ($p = 0.001$); and dinner ($p = 0.001$)]. Surprisingly, breakfast, lunch, and dinner provided approximately the same amount of energy from carbohydrates. Finally, snacks provided the lowest energy from protein [breakfast ($p = 0.020$); lunch ($p = 0.001$); and dinner ($p = 0.001$)] and breakfast was lower than lunch ($p = 0.002$) and dinner ($p = 0.001$), but lunch and dinner were not significantly different. In summary, for the overweight subjects, snacks and breakfasts were the smaller meals providing the fewest macronutrients and were similar in size. Lunch and dinner were the larger meals, providing most of the macronutrients and were also similar in size.

Macronutrient Composition of Meals

To gain a clearer understanding of the quality of meals, the total energy and macronutrient composition of each meal was analyzed using a MANOVA and no significant differences were found ($p > 0.05$). Again, there was a trend for overweight subjects to have a greater energy intake than the normal weight subjects for all meals (see Figure 2). For both groups, there was a trend for decreasing carbohydrate and increasing protein intake throughout the day. Interestingly, there were no significant differences found between the macronutrient composition of the groups' meals. For the normal

weight group, dinner provided the greatest amount of energy [$F(3) = 6.659$, $p = 0.014$]. Snacks were the smallest meals [breakfast: $F(3) = 6.659$, $p = 0.037$; lunch: $F(3) = 6.659$, $p = 0.003$; dinner: $F(3) = 6.659$, $p = 0.005$]. Breakfast was smaller than dinner [$F(3) = 6.659$, $p = 0.038$], but no different than lunch [$F(3) = 6.659$, $p = 0.105$]. For the overweight group, lunch and dinner were approximately the same size [$F(3) = 7.894$, $p = 0.861$] and provided greater amounts of energy than snacks [$F(3) = 7.894$, $p = 0.008$] and breakfast [$F(3) = 7.894$, $p = 0.001$]—which were approximately the same size [$F(3) = 7.894$, $p = 0.172$]. There were no group-by-meal interaction effects [NW: $F(3) = 0.00$, $p = 1.00$; OW: $F(3) = 0.00$, $p = 1.00$]. These data suggest that for both groups, the amount of energy intake increases throughout the day and that the breakfast meal more closely resembles snacks than either lunch or dinner.

Meal Frequency

The composition of each of meal becomes more important if all meals are not eaten each day. If individuals are following the USDA recommendation of three meals and two snacks per day, then their mean meal frequency should be close to 5 per day (USDA, 2000)—which is frequently not the case (Longnecker, Harper, & Soenhee, 1997). As shown in Table 5, the overweight subjects ate significantly more meals per day [$F(1) = 4.872$, $p = 0.037$] and more meals per week [$F(1) = 4.610$, $p = 0.042$]. Contrary to the hypothesis, the overweight subjects' meal patterns were actually closer to the USDA recommendations than were the normal weight subject who may frequently skip main meals (i.e., breakfast, lunch, or dinner). A Chi-Square analysis was used to further investigate which meals were eaten more regularly both between and within groups. There were no between-group differences for the frequencies of eating breakfast,

lunch, and dinner. There were no within group differences found for either group with the normal weight individuals eating each meal about half of the time and the overweight individuals eating each meal about two-thirds of the time. These data suggest that both groups of individuals regularly skip meals.

Exercise Patterns

Since energy intake is related to energy expenditure, the exercise patterns of the groups were compared using a repeated measures ANOVA (see Table 6). Activity levels were expected to differ between the groups with overweight subjects being less active. Significant differences between the groups' activity levels might further explain the similar daily energy intakes. These data were also collapsed across weeks because main effects for week and group-by-week interaction effects were not found.

Eighty-three percent of the normal weight subjects reported planned exercise (walking, etc.) at least once over the two-week period compared to sixty-five percent of the overweight subjects. The normal weight subjects also exercised significantly more frequently over the two-week period than did the overweight subjects [see Table 7; $F(1) = 4.376$, $p = 0.05$]. Normal weight subjects also reported significantly longer exercise sessions (in minutes) than did the overweight subjects [$F(1) = 5.195$, $p = 0.038$]. The data were logarithmically transformed due to the high variation within the groups. An analysis of the estimated energy expenditure through exercise revealed that the normal weights subjects expended significantly more energy through exercise over the two-week period [$F(1) = 4.752$, $p = 0.044$] and per exercise session [$F(1) = 1.141$, $p = 0.300$].

Greater understanding of the behavioral aspects of exercise habits will also further improve weight loss treatment programs. The time block (morning, afternoon, or

evening) chosen for exercise and the type of activity chosen may influence individuals to maintain exercise behaviors and could possibly influence energy intake throughout the day. For example, exercising in the morning could lead to a greater energy intake because the metabolic rate is raised or the individual may justify eating more throughout the day because she exercised in the morning. The mean percentage of time that each time block was chosen by subjects to exercise is presented in Table 7. Normal weight subjects were significantly more likely to exercise in the evening than the overweight subjects [$F(1) = 8.088$, $p = 0.011$], who were more likely to exercise in the morning [$F(1) = 6.130$, $p = 0.024$]. There were no significant differences between groups in the percentage of time the afternoon was chosen for exercise [$F(1) = 0.150$, $p = 0.704$].

The normal weight subjects exercised in the evening significantly more frequently than either the morning [$F(3) = 32.844$, $p = 0.021$] or the afternoon [$F(3) = 32.844$, $p = 0.000$]. There were no significant differences between the morning and the afternoon [$F(3) = 32.844$, $p = 0.333$]. The overweight group exercised significantly more frequently in the morning than the afternoon [$F(2) = 10.685$, $p = 0.014$], but there were no differences between the morning and evening frequencies [$F(2) = 10.685$, $p = 0.282$] and there was a trend for them to exercise more frequently in the evening than the afternoon [$F(2) = 10.685$, $p = 0.076$].

The normal weight subjects were also more likely to choose a variety of exercises. Table 8 presents the mean number of times an activity was chosen by subjects. The overweight subjects participated in walking [χ^2 (4, N = 8) = 2.00, $p = 0.736$] and cycling [χ^2 (2, N = 3) = 0.000, $p > 0.05$]. The normal weight subjects, on the other hand, participated in all of the categories of activities except swimming. However, walking [χ^2

(2, N = 3) = 0.000, $p > 0.05$] and aerobics [χ^2 (5, N = 6) = 0.667, p = 0.041] were the exercises of choice.

Eating and Exercise

Figure 3 depicts the relationships between energy intake and expenditure (minutes of exercise). For the normal weight group, the energy intake and length of exercise sessions were significantly correlated on day 2 [r^2 (5) = 0.837, p = 0.077], day 3 [r^2 (7) = 0.946, p = 0.001], day 6 [r^2 (5) = 0.891, p = 0.043], and day 7 [r^2 (2) = 1.00, $p < 0.001$]. This suggests that on 10 of the 14 days (or 71.43% of the time), the normal weight subjects' food intake did not increase as the length of exercise sessions increased. For the overweight group, energy intake and length of exercise sessions were significantly correlated on day 6 [r^2 (2) = 1.00, $p < 0.001$], day 7 [r^2 (2) = 1.00, $p < 0.001$], and day 13 [r^2 (2) = -1.000, $p < 0.001$]. Since none of the overweight subjects exercised on the first 5 days, correlations could not be conducted for these days. Based on the 9 days with exercise data, the overweight subjects' energy intake did not increase as the length of their exercise sessions increased 66.66% of the time. This could mean that overweight subjects' energy intake is more likely to relate to their energy expenditure. However, since this was a correlation analysis, no causal inferences can be made. Regardless of the directional relationship (i.e., whether increased food intake leads to more exercise or more exercise leads to greater food intake) these data support the hypothesis that both normal weight and overweight individuals balance their intake and expenditure of kilojoules to maintain their current weight.

Metabolic Rate

Metabolic rate was estimated and analyzed to further understand the similar energy intake of the two groups (see Table 9). Basal metabolic rate (BMR)—the lowest rate of energy exchange in the body that is associated with the maintenance of the autonomic functioning and body heat alone or the minimum rate of energy expenditure compatible with life (Schofield et al., 1985)—was calculated using Harris & Benedict's equation:

$$BMR = 655 + 9.5 \text{ (weight in kg)} + 1.9 \text{ (height in cm)} - 4.7 \text{ (age in years)}$$

According to Warwick & Baines (1996), daily metabolic rate (DMR), which is activity equivalent to sitting busily (e.g., secretarial work), can be estimated by multiplying the calculated BMR by 1.5. Individual active metabolic rates (AMR) were estimated by adding each subject's BMR to the mean number of calories burned per exercise session (Warwick & Baines, 1996).

As expected (given that BMR is partially based on weight), the overweight subjects' BMR's [$F(1) = 24.612$; $p = 0.001$] and DMR's [$F(1) = 243612$, $p = 0.001$] were significantly greater than the normal weight subjects'. The AMR's for the two groups, however, were not significantly different [$F(1) = 0.792$, $p = 0.382$]. The finding, in support of the hypothesis, that the AMR's were not significantly different means that due to conscious exertions of energy (i.e., exercise), normal weight subjects require approximately the same energy intake as their overweight counterparts—who exercise less frequently.

DISCUSSION

This study, although preliminary, is one of the first to compare the influences of

eating and exercise patterns of normal weight and overweight women to improve current dietary recommendations and weight programs. The findings suggest several differences in the eating and exercise patterns of normal weight and overweight women that may be important and are clearly worth further investigation. First, although neither groups' eating patterns resembled that of the USDA recommendation, the overweight individuals were surprisingly closer to following this pattern. However, this is an indication that both groups of subjects regularly skipped meals. Furthermore, the trend for both groups to balance energy intake and expenditure suggests that exercise may be a key factor in normal weight maintenance. Finally, these data support the hypothesis that normal weight individuals do not necessarily follow the USDA eating frequency recommendations, but do follow the quantity recommendations.

In impacting the guidelines for the current trends in weight treatment programs (e.g., low-fat or high-protein diets, etc.), the results of this study suggest that treatment programs may actually be more efficacious if the focus is shifted to the quantity of foods eaten rather than the macronutrient quality. Furthermore, the support for the importance of frequent, substantial exercise demonstrates that weight treatment and prevention programs would benefit from incorporating planned physical activity—especially those activities that cause higher rates of energy.

This study further supports that research incorporating longer observation periods, weighing foods (vs. estimating portion sizes), and the use of computers or other technology may more accurately capture natural food and exercise patterns. For example, daily variances in caloric intake and/or planned exercise suggest that outcome studies based on short monitoring periods may yield inaccurate snapshots of typical

energy intake and/or expenditure. Given that this group was not eating disordered, it may be worth further study to examine if this is a "successful" pattern for maintaining normal weight. Recommendations for healthy eating and weight maintenance are made based on "common sense" as opposed to empirical findings. The findings of this study call into question whether or not overweight women should be encouraged to stick with the "standard" meal pattern especially since the general population is much more sedentary now than ever before. Consistent with current recommendations, these findings do suggest overweight women may need to both decrease caloric intake and/or increase physical activity.

The relationship seen between eating and exercising is interesting because of the potential causal relationship: overweight individuals may be using the event of exercise to justify eating more—regardless of the actual number of calories burned during the exercise session—or exercising in the morning could actually cause increased appetite throughout the day. Normal weight subjects may also be doing this, however, they are exercising more vigorously, for greater lengths of time, and expending a greater amount of energy—which balances additional caloric intake. Therefore, this relationship should be examined in future research.

Limitations and Future Directions

A primary limitation of this study is sample size which increased variance and decreased power. Consequently, the power of this study may not have been high enough to detect any significant differences if, in fact, they exist. Since power analyses revealed that the power of the study was low (approximately .3563), this explanation is probably at least partially true. The current study should be replicated to increase the total subject

number to 76 (38 in each group). This would increase the power of the study to 0.80—significantly improving the chances of detecting significant differences that exist (Faul & Erdfelder, 1992). Despite the fact that the power of the current study was relatively low, the trends found and the findings that were statistically significant further support the theory that current "normal" eating patterns do not reflect the recommended "healthy" eating patterns.

Another limitation of the current study was that metabolic rate was not measured (e.g., respirometer, etc.) but instead estimates were used. The method used to calculate metabolic rates is subject to several confounds that could be addressed in future studies of metabolic output measured physiologically. For example, equations used to estimate BMR have been subject to a great deal of debate over accuracy with all subject groups and lack of sensitivity to variables that influence metabolic rate (e.g., gross muscular activity, post-absorptive state, body temperature, emotional state, nutritional status, and phase of menstrual cycle for women). Controlling for these issues and measuring BMR should be incorporated into future studies.

In summary, despite the limitations of the current study, the findings suggest that current weight management recommendations need to be re-evaluated. Furthermore, measures of metabolic rate should be incorporated into studies requiring self-monitoring of food intake to ensure accuracy of recording and consequently accuracy of data.

REFERENCES

Akan, G.E. & Grilo, C.M. (1995). Sociocultural influences on eating attitudes and behaviors, body image, and psychological functioning: A comparison of African-American, Asian-American, and Caucasian college women. International Journal of Eating Disorders, 18 (2), 181-187.

Allan, J.D. (1998). Explanatory models of overweight among African American, Euro-American, and Mexican American Women. Western Journal of Nursing Research, 20 (1), 45-66.

American Dietetic Association & Kirby, J. (2000, April). Excerpts from Dieting for dummies [On-line]. Available: http://www.eatright.org/dieting.html.

Booth, D.A. (1999). Evidence-based reduction of obesity: Identification of a subculture's least fattening eating patterns. Appetite, 32, 80-85.

Bourne, S.K., Bryant, R.A., Griffiths, R.A., Touyz, S.W., & Beumont, P.J.V. (1998). Bulimia Nervosa, restrained, and unrestrained eaters: A comparison of non-binge eating behavior. International Journal of Eating Disorders, 24, 185-192.

Brownell, K.D., & Wadden, T.A. (1992). Etiology and treatment of obesity: Understanding a serious, prevalent, and refractory disorder. Journal of Consulting and Clinical Psychology, 60 (4), 505-517.

Cash, T.F., & Hicks, K.L. (1990). Being fat versus thinking fat: Relationships with body image, eating behaviors, and well-being. Cognitive Therapy and Research, 14 (3), 327-341.

Cavadini, C., Decarli, B., Dirren, H., Cauderay, M., Narring, F., & Michaud, P.A. (1999). Assessment of adolescent food habits in Switzerland. Appetite, 32, 97-106.

Comperatore, C.A. & Krueger, G.P. (1990). Circadian rhythm desynchronosis, jet lag, shift lag, and coping strategies. Occupational Medicine: State of the Art Reviews, 5 (2), 323-341.

Compute-A-Diet Nutrient Balance System [Computer Software]. (1992). Worcestershire, England: COMCARD LTD.

Conforto, R.M., & Gersham, L. (1985). Cognitive processing differences between obese and nonobese subjects. Addictive Behaviors, 10, 83-85.

Fairburn, C.G. & Wilson, G.T. (Eds.). (1993). Binge eating: Nature, assessment, and treatment. New York: Guilford Press.

Faul, F. & Erdfelder, E. (1992). GPOWER: A priori, post-hoc, and compromise power analysis for MS-DOS [computer program]. Bonn, FRG: Bonn University, Department of Psychology.

Fries, E., Green, P., & Bowen, D.J. (1995). What did I eat yesterday? Determinants of accuracy in 24-hour food memories. Applied Cognitive Psychology, 9, 143-155.

Ganley, R.M. (1992). Family patterns in obesity: With consideration of emotional eating and restraint. Family Systems Medicine, 10 (2), 181-199.

Hagan, M.M., & Moss, D.E. (1997). Persistence of binge-eating patterns after a history of restriction with intermittent bouts of refeeding on palatable food in rats: Implications for bulimia nervosa. International Journal of Eating Disorders, 22, 411-420.

Head, S., & Brookhart, A. (1997). Lifestyle modification and relapse-prevention training during treatment for weight loss. Behavior Therapy, 28, 307-321.

Hjordis, B., Gunnar, E., & Daisy, S. (1989). Personality traits related to eating

behavior and weight loss in a group of severly obese patients. International Journal of Eating Disorders, 8 (3), 315-323.

Johnson, W.G., Schlundt, D.G., Barclay, D.R., Carr-Nangle, R.E., & Engler, L.B. (1995). A naturalistic functional analysis of binge eating. Behavior Therapy, 26, 101-118.

Keesey, R.E. (1986). A set-point theory of obesity. In K.D. Brownell & J.P. Foreyt (Eds.), Handbook of eating disorders: Physiology, psychology, and treatment of obesity, anorexia, and bulimia (pp. 63-87). New York: Basic Books.

Kowrygo, B., Gorska-Warsewicz, H., & Berger, S. (1999). Evaluation of eating patterns with different methods: The Polish experience. Appetite, 32, 86-92.

Lennernas, M., & Andersson, I. (1999). Food-based classification of eating episodes (FBCE). Appetite, 32, 53-65.

Lin, B.H., Guthrie, J., & Frazao, E. (2000, August). Nutrient contribution of food away from home. In E. Frazao (Ed.), America's eating habits: Changes and consequences. [On-line]. Available: www.ers.usda.gov/epubs/pdf/aib7501.

Longnecker, M.P., Harper, J.M., & Seonhee, K. (1997). Eating frequency in the nationwide food consumption survey (USA), 1987-1988. Appetite, 29, 55-59.

Lowe, M.R.; Gleaves, D.H.; McKinney, S., DiSimone-Weiss, R.T., Furgueson, C., Gayda, C.A., Kolsky, P.A., Neal-Walden, T., Nelson, L.A. (1996). Restraint, dieting, and the Continuum Model of Bulimia Nervosa. Journal of Abnormal Psychology, 105 (4), 508-517.

Menon, G. (1993). The effects of accessibility of information in memory on judgments of behavioral frequencies. Journal of Consumer Research, 20, 431-440.

Menon, Raghubir, P., & Schwarz, N. (1995). Behavioral frequency judgments: An accessibility-diagnosticity framework. Journal of Consumer Research, 22, 212-228.

Mertz, W., Tsui, J.C., Judd, J.T., Reiser, S., Hallfrisch, J., Morris, E.R., Steele, P.D., & Lashley, E. (1991). What are people really eating? The relation between energy intake derived from estimated diet records and intake determined to maintain body weight. American Journal of Clinical Nutrition, 54, 291-295.

Muhlheim, L.S., Allison, D.B., Heshka, S., & Heymsfield, S.B. (1998). Do unsuccessful dieters intentionally underreport food intake? International Journal of Eating Disorders, 24 (3), 259-266.

Nestle, M., & Woteki, C. (1999). Interpretation of dietary change in the United States: Fat as an indicator. Appetite, 32, 107-112.

Nutritionist IV [Computer Software]. (1993). California: First Databank.

Perez, C., Fanizza, L.J., & Sclafani, A. (1999). Flavor preferences conditioned by intragastric nutrient infusions in rats fed chow or a cafeteria diet. Appetite, 32, 155-170.

Pfau, C. (1999). Methodology of a survey on meal patterns in private senior households. Appetite, 32, 38-45.

Popkin, B.M., Haines, P.S., & Siega-Riz, A.M. (1999). Dietary patterns and trends in the United States: The UNC-CH approach. Appetite, 32, 8-14.

Prattala, R., & Roos, E. (1999). From regional ethnographies to interdisciplinary approaches--Research on meals in Finland. Appetite, 32, 66-72.

Putnam, J. & Gerrior, S. (2000, August). Trends in the U.S. food supply, 1970-97. In E. Frazao (Ed.), America's eating habits: Changes and consequences. [On-line]. Available: www.ers.usda.gov/epubs/pdf/aib7501.

Pi-Sunyer, F.X. (1996). Current approaches to the management of obesity. New York: F.X. Pi- Sunyer.

Pi-Sunyer, F.X., Dietz, W.H., Becker, D.M., Foreyt, J.P., et al. (1998). Clinical guidelines on the identification, evaluations, and treatment of overweight and obesity in America. Bethesda: NIH.

Ricciardelli, L.A., Tate, D., & Williams, R.J. (1997). Body dissatisfaction as a mediator of the relationship between dietary restraint and bulimic eating patterns. Appetite, 29, 43-54.

Roos, E., & Prattala, R. (1997). Meal pattern and nutrient intake among adult Finns. Appetite, 29, 11-24.

Rozin, P., Ashmore, M., & Markwight, M. (1996). Lay American conceptions of nutrition: Dose insensitivity, categorical thinking, contagion, and monotonic mind. Health Psychology, 15 (6), 438-447.

Ruderman, A.J. (1986). Dietary restraint: A theoretical and empirical review. Psychological Bulletin, 99, 247-262.

Sbrocco, T., Nedegaard, R.C., Stone, J.M., & Lewis, E.L. (1999). Behavioral Choice Treatment promotes continuing weight loss: Preliminary results of a cognitive-behavioral decision-based treatment for obesity. Journal of Consulting and Clinical Psychology, 67(2), 260-266.

Schlettwein-Gsell, D., Decarli, B., & DeGroot, L. (1999). Meal patterns in the SENECA study of nutrition and the elderly in Europe: Assessment method and preliminary results on the role of the midday meal. Appetite, 32, 15-22.

Schlundt, D.G. (1995). Assessment of specific eating behaviors and eating style.

In D. B. Allison (Ed.), Handbook of assessment methods for eating behaviors and weight-related problems: Measures, theory, and research (pp. 241-302). Thousand Oaks: Sage Publications.

Schlundt, D.G. & Johnson, W.G. (1990). Eating disorders: Assessment and treatment. Needham Heights, MA: Allyn and Bacon.

Schlundt, D.G., Johnson, W.G., & Jarrell, M.P. (1985). A naturalistic functional analysis of eating behavior in bulimia and obesity. Advances in Behavior Research and Therapy, 7 149-162.

Schlundt, D.G., Virts, K.L., Sbrocco, T., & Pope-Cordle, J. (1993). A sequential behavioral analysis of craving sweets in obese women. Addictive Behaviors, 18, 67-80.

Schoeller, D.A. (1988). Measurement of energy expenditure in free-living humans by using doubly labeled water. Journal of Nutrition, 118, 1278-1289.

Smith, A.F. & Jobe, J.B. (1993). Validity of reports of long-term dietary memories: Data and a model. In R. Schwarz & S. Sudman (Eds.), Autobiographical memory and the validity of retrospective self-report (pp.121-140). New York: Springer-Verlag.

Smith, A.F., Jobe, J.B., & Mingay, D.J. (1991). Retrieval from memory of dietary information. Applied Cognitive Psychology, 5, 269-296.

Stanley, B.G., Schwartz, D.H., Hernandez, L., Leibowitz, S.F., & Hoebel, B.G. (1989). Patterns of extracellular 5-hydroxyindoleacetic acid (5-HIAA) in the paraventricular hypothalamus (PVN): Relation to circadian rhythm and deprivation-induced eating behavior. Pharmacology, Biochemistry, & Behavior, 33, 257-260.

Stunkard, A., Harris, J., Pedersen, N., & McClearn, G. (1990). A separated twin

study of the body mass index. New England Journal Of Medicine, 322, 1483-1487.

Tippett, K.S.& Cleveland, L.E. (2000, August). How current diets stack up: Comparison with dietary guidelines. In E. Frazao (Ed.), America's eating habits: Changes and consequences. [On-line]. Available: www.ers.usda.gov/epubs/pdf/aib7501.

Tukey, J. (1997). More honest foundations for data analysis. Journal of Statistical Planning and Inference, 57, 21-28.

U.S. Department of Agriculture. (2000, April). Food and Nutrition Information Center [On-line]. Available: http://www.nal.usda.gov/fnic.

Wadden, T.A., Foster, G.D., & Letizia, K.A. (1994). One-year behavioral treatment of obesity: Comparison of moderate and sever caloric restriction and the effects of weight maintenance therapy. Journal of Consulting and Clinical Psychology, 62 (1), 165-171.

Wardle, J., Steptoe, A., Bellisle, F., Davou, B., Reschke, K., & Lappalainen, R. (1997). Healthy dietary practices among European students. Health Psychology, 16 (5), 443-450.

Wahlqvist, M.L., Kouris-Blazos, A., & Wattanapenpaiboon, N. (1999). The significance of eating patterns: An elderly Greek case study. Appetite, 32, 23-32.

Westerterp-Plantenga, M.S., Wouters, L., & Ten Hoor, F. (1991). Restrained eating, obesity, and cumulative food intake curves during four-course meals. Appetite, 16, 149-158.

Westerterp, K.R., Nicolson, N.A., Boots, J.M.J., Mordant, A., & Westerterp, M.S. (1988). Obesity, restrained eating and the cumulative intake curve. Appetite, 11, 119-128.

Wilson, G.T. & Vitousek, K.M. (1999). Self-monitoring in the assessment of eating disorders. Psychological Assessment, 11 (4), 480-489.

Winkler, G., Doring, A., & Keil, U. (1999). Meal patterns in middle-aged men in southern Germany: Results from the MONICA Augsburg dietary survey 1984/85. Appetite, 32, 33-37.

Wurtman, J.J (1988). Carbohydrate craving, mood changes, and obesity. Journal of clinical psychiatry, 49 (8), 37S-39S.

TABLES

Table 1.

Demographic Information

Group	n	Weight (kg)	BMI (kg/m^2)	Height (m)	Age (yrs)	Education (yrs)
NW	12					
M (SD)		57.08 (5.32)	21.28 (1.80)	1.64 (0.05)	35.58 (10.47)	14.36 (2.38)
OW	17					
M (SD)		84.50 (13.14)	30.68 (3.87)	1.66 (0.016)	43.29 (9.91)	14.53 (3.42)
95% Confidence Interval		-35.68 to -19.166	-11.87 to -7.18	-0.06 to -0.02	-12.56 to 3.14	-2.74 to 2.02

*Note. Weight in lbs: NW: 125.73 (11.73); OW: 186.13 (28.95); Height in inches: NW: 64.48 (1.81); OW: 65.25 (0.006).

Table 2.

Mean Daily Kilojoules, Kilocalorie, and Fat Intake by Week

		Week					
		1			2		
Group	n	kJ	kCal	Fat (gm)	kJ	kCal	Fat (gm)
NW	11	7740.64	1850.06	69.56	6131.67	2124.88	54.19
M (SD)		(2398.12)	(573.17)	(30.01)	(2512.09)	(619.77)	(25.77)
OW	15	8890.48	1465.50	88.59	8534.65	2039.83	79.70
M (SD)		(2593.12)	(600.40)	(29.58)	(2926.51)	(699.45)	(34.33)

Table 3.

Mean Daily Energy Intake by Kilojoules, Kilocalories, and Fat

Group	n	Kilojoules	Kilocalories	Fat (grams)
NW	11			
M (SD)		6627.48 (2045.78)	1584.01 (488.95)	62.44 (21.11)
OW	15			
M (SD)		8201.96 (2096.64)	1960.31 (501.11)	82.26 (26.45)

Table 4.

Macronutrient Composition of Daily Energy Intake

		Percentage of Kilojoules from Macronutrients		
Group	n	% Fat	% Carb.	% Protein
NW	11			
M (SD)		35.91 (6.81)	56.30 (31.16)	20.51 (11.36)
OW	15			
M (SD)		37.91 (7.43)	54.28 (19.36)	17.32 (5.78)

Table 5

Frequency and Percentage of the Time Meals were Eaten

Group	Meals/Day	Meals/Week	Meal* Breakfast	Lunch	Dinner	Snack
NW	2.63 (0.80)	18.18 (6.70)	57.01	54.35	52.42	49.85
M (SD)			(35.37)	(33.68)	(34.17)	(37.29)
OW	3.29 (0.72)	23.20 (5.24)	68.85	66.28	73.29	76.83
M (SD)			(29.36)	(25.44)	(28.19)	(54.83)
95% Confidence Interval	2.68 to 3.34	18.53 to 23.62	7.13 to 10.74	6.92 to 10.22	7.22 to 10.83	6.37 to 11.94

*Note. Percentage of time the meal was eaten over the two-week period. For example, normal weight subjects ate breakfast 56.91% of the time over the two-week period.

Table 6.

Exercise Sessions over Two-Week Period

Group	n	Number of days exercised	Length of sessions (min.)	kJ burned per session	Total kJ burned
NW	9				
M (SD)		6.89 (4.59)	126.60 (141.65)	1653.38	8127.50
				(1651.74)	(5591.58)
OW	10				
M (SD)		3.55 (2.42)	41.31 (22.57)	1049.89	3577.49
				(656.30)	(3344.77)
95% Confidence Interval		3.24 to 6.86	27.15 to 139.42	740.79 to 1930.72	3325.82 to 8139.68

*Note. KCal burned per session: NW: 391.91 (396.92); OW: 250.93 (156.86); Total kCal burned: NW: 1942.52 (1336.42); OW: 855.04 (799.42).

Table 7.

Exercise Percentages by Time of Day

Group	Time of Day		
	Morning*	Afternoon	Evening
NW			
M (SD)	16.59 (32.06)	5.00 (10.00)	78.41 (33.46)
OW			
M (SD)	60.75 (43.97)	7.5 (16.87)	31.75 (37.60)

*Note. Percentage of time the period of day was chosen for exercise.

Table 8.

Exercise Frequencies by Activity

	Normal Weight	Overweight
Aerobics	4.33 (2.80)	0.00 (0.00)
Cycling	1.67 (1.15)	3.00 (2.65)
Gardening	1.50 (0.71)	1.00 (0.00)
Housework	1.50 (0.71)	0.00 (0.00)
Jogging	5.00 (0.00)	0.00 (0.00)
Rowing	3.00 (0.00)	0.00 (0.00)
Swimming	0.00 (0.00)	0.00 (0.00)
Walking	6.00 (5.29)	3.13 (2.42)
Weight Lifting	2.00 (1.00)	0.00 (0.00)
Other	2.00 (0.00)	0.00 (0.00)

Table 9.

Estimated Metabolic Rate

Group	Metabolic Rate* Basal	Daily	Active
NW M (SD)	1324.94 (56.91)	1656.18 (71.14)	1976.84 (398.06)
OW M (SD)	1534.73 (130.92)	1918.41 (163.65)	2085.70 (222.70)

*Note: Estimated using Harris and Benedict's (1919) equation:
BMR = 655 + 9.5 (wt) +1.9 (ht) – 4.7 (age)

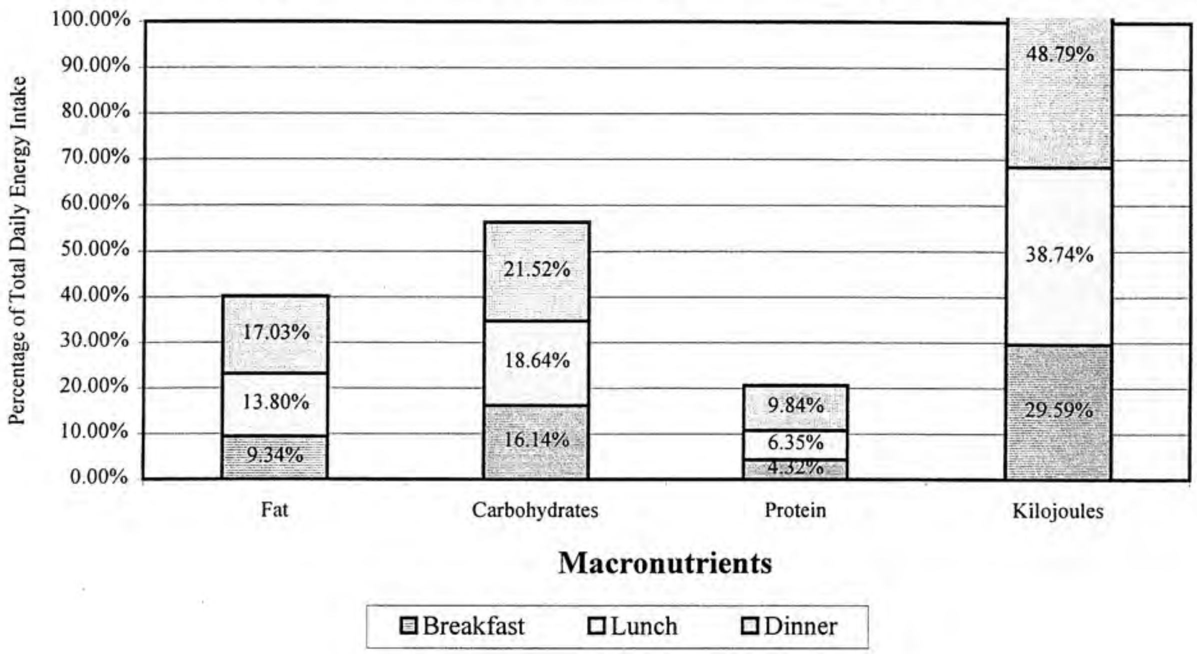
FIGURES

Figure 1

Macronutrient Composition of Daily kJ Intake by Meals

NORMAL WEIGHT

Daily Intake: kJ: 6627.48 (2045.78); kCal: 1548.01 (488.95)



OVERWEIGHT

Daily Intake: kJ: 8201.96 (2096.64); kCal: 1548.01 (488.95)

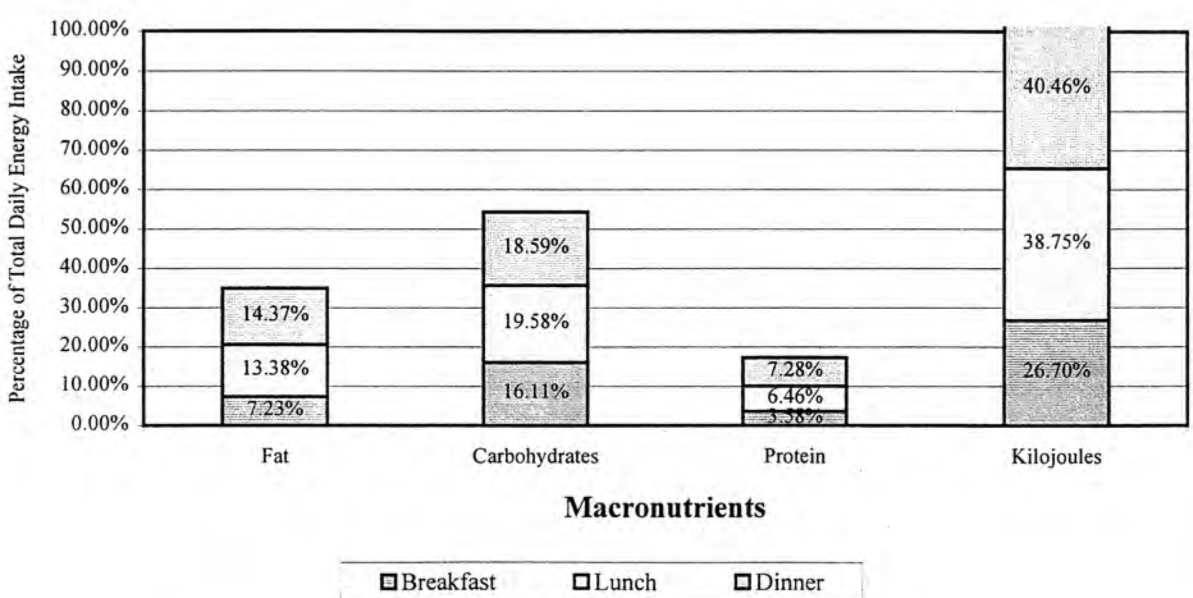
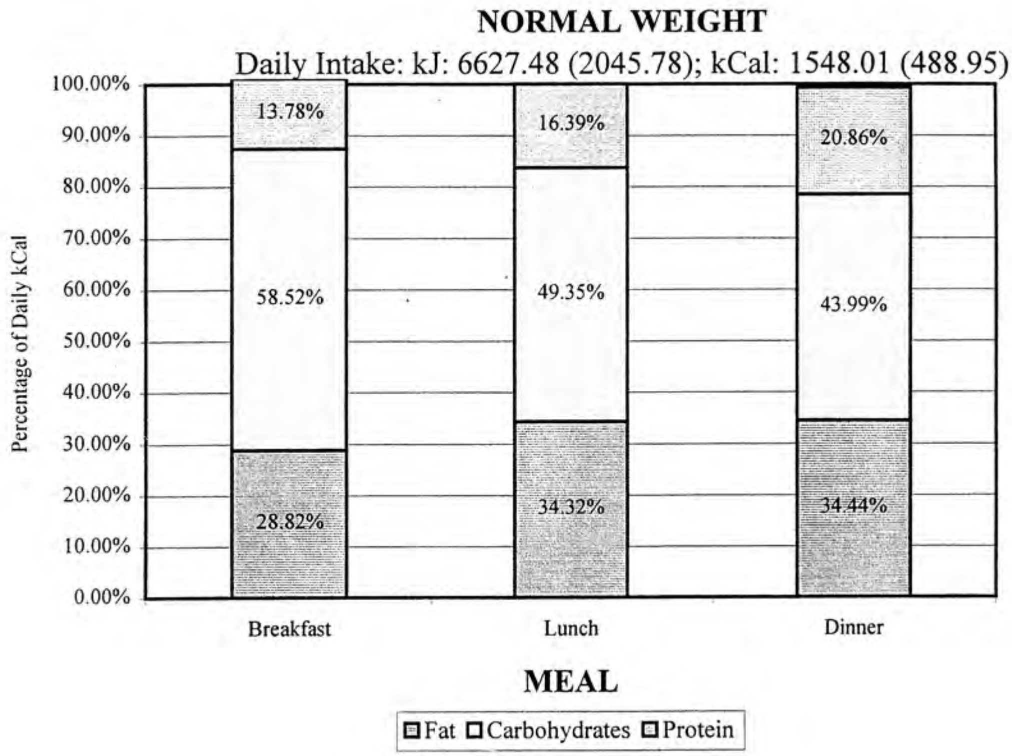


Figure 2

Meal Compositions



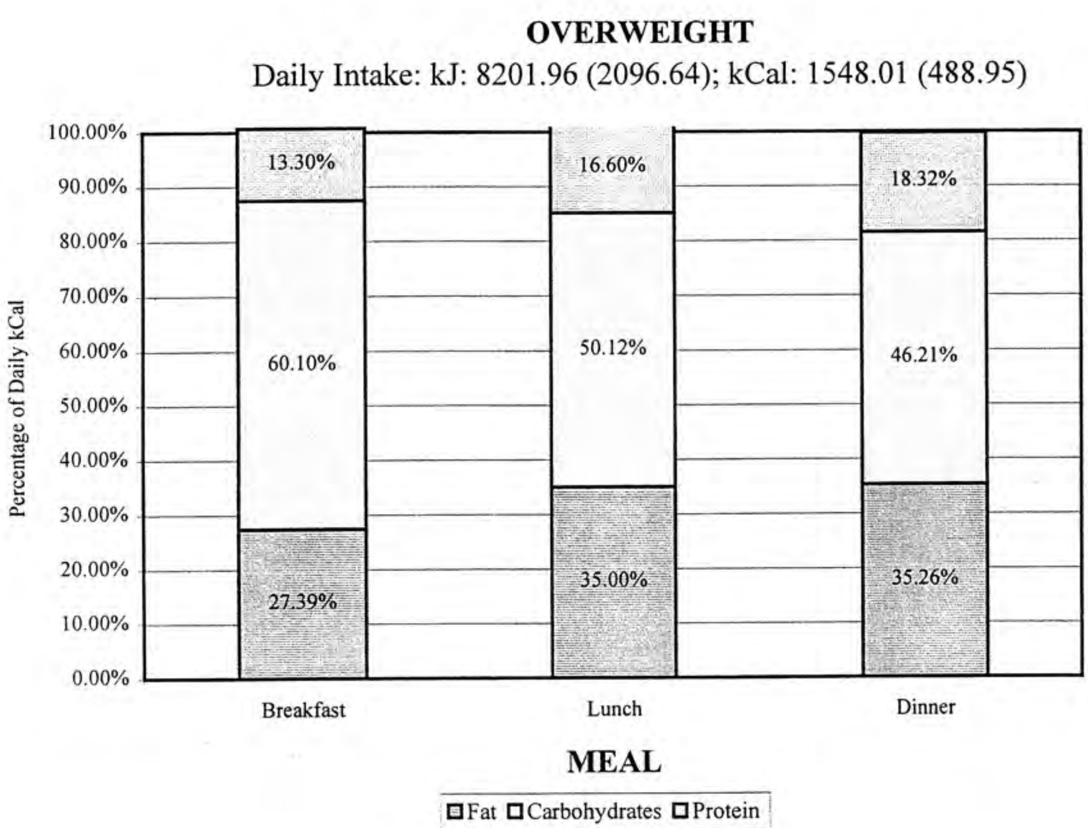
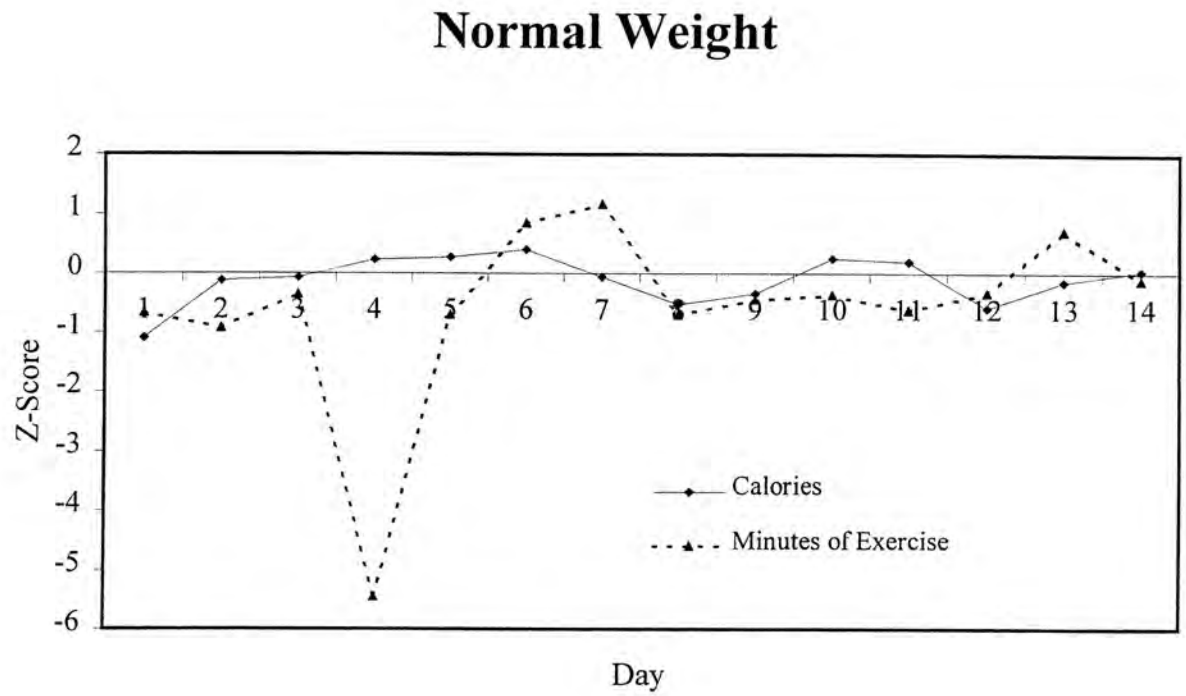
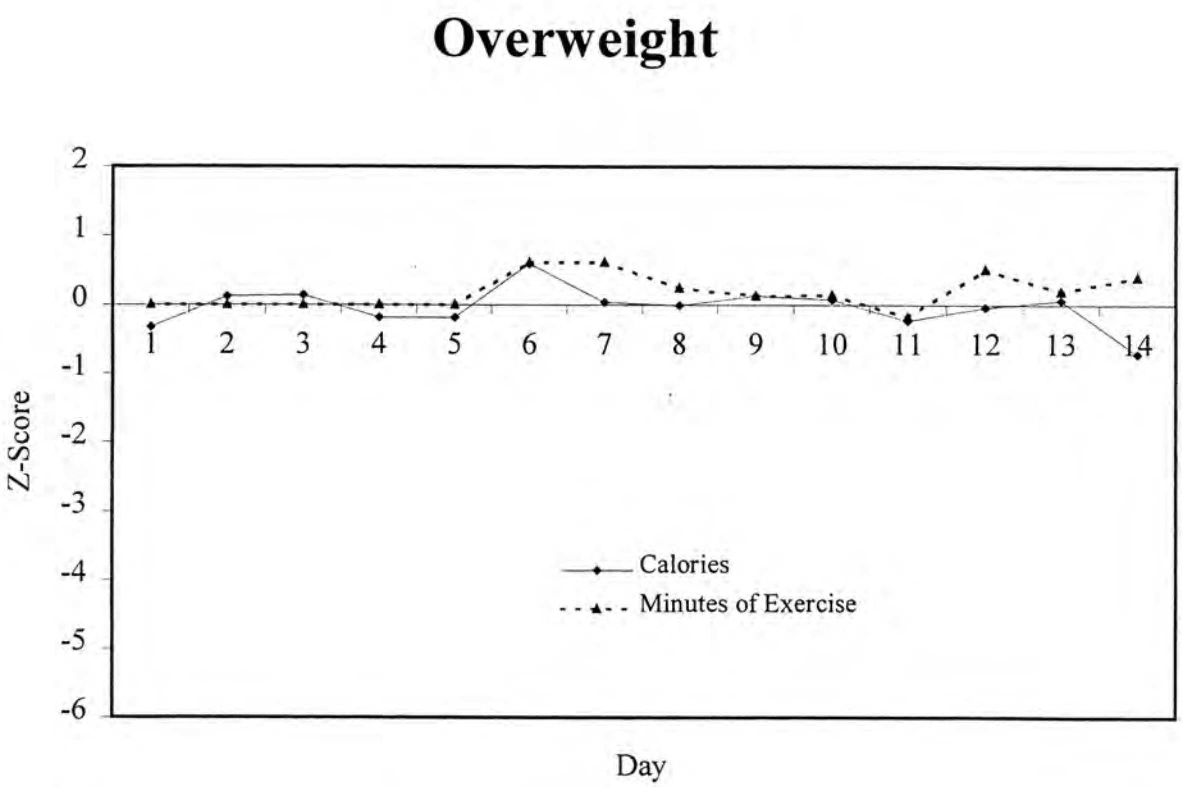


Figure 3

Eating/Exercise Trends





APPENDIX

Table 10.

Prevalence of Overweight and Obesity Among Adults

	1960-62	1988-94	Change/year
Men	48.2	59.4	0.40
Women	38.7	50.7	0.43
White, non-Hispanic men	52.0*	61.0	0.75
White, non-Hispanic women	36.1*	49.2	1.09
Black, non-Hispanic men	48.9*	56.7	0.65
Black, non-Hispanic women	60.6*	66.0	0.45
Mexican-American men	59.7**	63.9	0.70
Mexican-American women	60.1**	65.9	0.97

Note: * indicates 1976-1980; ** indicates 1982-1984. Adapted from Pi-Sunyer et al. (1998).